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Physical & Applied Sci. Serials

Thirty-third Annual Report of the Savilian Professor of Astronomy to the Visitors of the University Observatory for 1907–8.

BOARD OF VISITORS, 1908.

THE VICE-CHANCELLOR (Thomas Herbert Warren, M.A., President of Magdalen).

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THE DIRECTOR OF THE CAMBRIDGE OBSERVATORY (Sir R. S. Ball, M.A., LL.D., F.R.S.).

THE RADCLIFFE OBSERVER (A. A. Rambaut, M.A., D.Sc., F.R.S).

WILLIAM ESSON, M.A., F.R.S., Fellow of New College. SIR WILLIAM HUGGINS, K.C.B., O.M., Hon. D.C.L., F.R.S.	For ten years until Dec. 11, 1910.
EDWIN B. ELLIOTT, M.A., F.R.S., Fellow of Magdalen. CHARLES LEUDESDORF, M.A., Fellow of Pembroke.	For ten years until Nov. 10, 1915.

THE REPORT here presented refers to the period from May 1, 1907, to April 30, 1908, and exhibits the state of the Observatory on the last-named day.

As a brief summary, two more of the eight proposed volumes of the Astrographic Catalogue (Oxford portion, Zones $+31^\circ$ to $+25^\circ$) have been published, making four in all, and a fifth is partly printed.

The Astrographic Equatorial, which has been in use almost continuously since 1891, was dismounted for cleaning, repair, and improvement, under the superintendence of Mr. A. B. Chatwood: and some other instrumental changes have also been made. The total expense, though much less than it might have been had not an exceptionally favourable opportunity been utilized, is nevertheless heavy; and it is suggested that an application be made to the Trustees of Lord Leigh's Fund for a grant in aid.

The great piece of work undertaken in 1891 is approaching completion, and it may be considered desirable that it should be followed by work of a different character, such as some form of spectroscopic work. An opportunity presented itself somewhat suddenly last summer for Mr. H. C. Plummer to spend a year at the Lick Observatory in California, under conditions approved by the Board. He will thus make a working acquaintance with the best modern apparatus and methods; and this experience will be very valuable to us if it should be decided to include spectroscopic work in our programme after his return.

I. Buildings and Grounds.

The canvas of the smaller (De la Rue) dome was repaired and painted by Messrs. Thomas & Son in September last. The recent severe snowstorm of April 25 caused us some anxiety, and Mr. Bellamy and Mullis spent Saturday afternoon clearing (so far as was possible in still falling snow) the flat roof of the lecture-room and other portions of the building where accumulations of snow were likely to do damage. Thanks to their considerable exertions no harm was done.

II. Library and Movable Property.

The binding of pamphlets and observatory publications, which was somewhat in arrear, has been brought up to date. We are beginning to feel the difficulty of limited shelf-room, but as yet not acutely. The rate of accumulation, including necessary magazines, almanacs, and works of reference, is about four feet of shelf-room per year.

As much work on variable stars has been done and is being done at this Observatory, Father Hagen's "Atlas Stellarum Variabilium" has been purchased, and is in constant use. This exceptional item and the extra cost of binding pamphlets make the annual expenditure on the Library unusually large.

The completion of the receptacle for lantern slides has been delayed by the work on the equatorial ; but the main structure is in position and the sliding frames will be added within a few weeks.

III. Instruments.

In September, 1907, it was found that the clock of the Astrographic Equatorial could not be trusted to drive the instrument properly. The telescope had been many years in almost continuous use, and no doubt required cleaning ; but it was kept going in order to complete our work under as nearly as possible the same conditions. It so happened that Mr. A. B. Chatwood was on a visit to the Observatory, with the view of discussing plans for a new observatory in India, and of making himself familiar with our methods of work. Mr. Chatwood is an engineer of wide experience, including a general acquaintance with astronomical work, and was awaiting the confirmation of an appointment as Astronomer to H.H. the Nizam of Hyderabad, though the formalities were expected to take some months. (On the completion of these formalities he left England on March 6, 1908, and is now definitely established at Hyderabad.) He inspected the instrument and gave it as his opinion that he could arrange for it to be dismounted and repaired on the spot, which would save the great labour and expense of sending it away ; and he estimated that he could carry out the work before his departure, if I placed it in his hands. This, after a little consideration, I determined to do, and the arrangement was mentioned to the Board on November 19. But the necessary work turned out to be much more extensive than was at first expected. Mr. Chatwood devoted himself to it untiringly, and, in spite of the unforeseen additions, completed it in essentials before his departure ; as well as some minor matters which he also kindly undertook. I append his report on the work.

But it remains to point out that the Observatory funds have been run very low by this exceptional expenditure, to which is to be added other expenditure mentioned below on the Transit Circle, the improvement of our measuring micrometers, the provision of arc lights for photometry and for the lecture lantern, and substantial repairs to the sunshine recorder; and it is for the Board to consider whether a special application for expenditure on instruments might not be made to the Trustees of Lord Leigh's Fund which is for

> "purchasing models and a proper apparatus for exemplifying and illustrating the Mathematical Lectures and Experiments formerly read and explained by Dr. Bradley and Mr. Bliss." (*University Gazette*, April 26, 1904.)

The march of events has made it difficult to comply precisely with the terms of the bequest; but it seems reasonable that in widening the application, some place may be found for the occasional special needs of the Savilian Professors, whose predecessors are specifically mentioned. If a grant could be made at this juncture, it would greatly relieve the stress on the Observatory funds.

Mr. Chatwood's Report on the Astrographic Equatorial.

"The original telescope by Grubb was erected in 1874 as a 12¼ inch visual; the 13 inch photographic object-glass and tube presented by Dr. Warren de la Rue were added by Grubb in 1891. In 1900 the old dome was replaced by one of Cooke's 23½ ft. standard domes. The dismantling of the old dome and erection of the new one occupied some four months (May to August), during which time the instrument (except for the O.Gs and certain easily removable parts) was covered by tarpaulins. There is little doubt that much injury was done to the bearings of the instrument by the prolonged retention of the old leaky dome. In September, 1907, it was found on examination that the clock could not be relied upon to drive the telescope, owing partly to the fact that the clock and gearing required cleaning, but chiefly to the rusting of the polar-axis main bearing. The clamp in R. A. was erratic in its action. The declination axis also did not turn evenly and easily. A few of the brass parts were badly pitted through the lacquer, as is only natural after so many years' exposure. The electric illumination of the circles which had been added was not convenient, owing to the use of loose wires which were liable to foul the instrument. The slow motion in R.A. could not be used unless the telescope was on the west side of the pier and then only within a limited range. The reading marks on the declination circle were not satisfactory, and were so arranged that they were liable to come into contact with the declination circle and cause damage; in fact some damage had already been caused in this manner.

The gearing of the electric control was neither efficient nor trustworthy in its action, as the wheels and pinions were not correctly pitched, and the pinions, two in number instead of four, were not supported with sufficient rigidity.

As it was impossible to remedy the defects in the axes or in the R.A. clamp without dismounting the whole instrument, it was decided to dismantle it, and work was commenced on November 15 last (after the transit of Mercury, of which a glimpse was obtained through the telescope).

The object-glasses and eye-pieces having been removed, the telescope tubes were turned into a horizontal position on the west side of the pier, and packed up in this position on builders' trestles, and a working scaffold having been erected round the mount, the tubes were separated from the declination axis and left on the trestles, until reconnected to the axis.

When the mount was taken to pieces, it was found that all the brass work, instead of only a small part, was badly pitted, and it was decided to clean off all lacquer, polish and relacquer with the best lacquer obtainable—a decision which involved nearly doubling the work previously contemplated.

The polar and declination axes on examination were found to be badly rusted (the trouble probably being largely due to the old leaky dome and to the necessary covering of the instrument with tarpaulins during the construction of the new dome), and the declination axis was also badly grooved, owing to the construction of the main bearing. Arrangements having been made with Messrs. Lucy and Co. for use of their large lathe, these axes were taken to their foundry, and there re-turned and polished by Mr. Chatwood, and the gun-metal bearing blocks scraped up to fit the bearings. As it was found that no provision had been made for setting the collimation axes of the telescopes at right angles to the declination axis, the attachment of the saddle to this axis was altered, and four "pushing" screws fitted (these screw-heads have been painted red to avoid confusion). The illumination of the two reading points of the declination circle, of the field, and of the eye-piece micrometer has now been arranged as follows :— [The details need not be given here.] Summarizing: both poles of the battery are brought to the eye end, and each lamp separately wired from here. The switch is so arranged that only one lamp can be in circuit at one time, and by withdrawing the interrupting plug at the close of work, any lamp left switched on is cut off. This illumination is provided by the 4-volt secondary batteries in the basement.

The illumination of the hour circle, involving no moving wires, has been re-arranged to take a 100-volt lamp with current direct from the 100-volt mains.

New frames carrying the declination setting marks engraved on silver have been fitted, and provision has been made to prevent these in future coming into contact with the circle. New lamp holders and lamps to this circle, suitable to the lower voltage, have been fitted.

An entirely new arrangement has been designed and fitted for operating the R.A. slow motion screw by a continuous cord from the eye end of the telescope in any position.

The declination slow motion rod was found to be fouling the cradle screws, with the result that one of the tubular rods had been split by the continual bending. This has been refitted to the opposite side, where there is ample room, and the split rod replaced.

The electro-magnets of the control were found deficient in power when the batteries were not fully charged, so that new and more powerful magnets have been made and fitted.

The differential wheel arrangements of the control were neither very efficient nor very reliable; these arrangements have been re-designed, and new wheels and pinions fitted: the chief points of improvement being steel instead of brass pinions, the pinions being supported at both ends instead of one end only, and the work divided between four pinions instead of two.

The object-glasses have been thoroughly cleaned, and the cell of the visual so modified as to allow the object-glass to be taken out, cleaned, and replaced with much greater facility, and pushing screws have been fitted to the cell to enable the visual O.G. to be squared on.

The micrometer eye-end fitted to the visual was so tightly fitted to the tube that it required a hammer to remove it, so that the telescope was quite useless for anything except the astrographic work, as it was not feasible to change the eye-ends. Facility in the rapid and convenient exchange of one eye-end for another is, in the best modern observatories, considered as of very great importance, as it enables the staff to make the fullest use of the instrument.

The socket of the micrometer eye-end has been turned out to fit the tube, and the six screws which formerly held it replaced by four, three of which remain in position, whilst the eye-ends are interchanged (the sockets having been made into bayonet joints), and the fourth, with a milled head, acting as a safety-key, and being the only one moved.

A more convenient method of balancing the telescope has been designed, but it has not yet been possible to make and fit this. Unfortunately finances did not allow of the complete renovation of the whole instrument at the present time, so that beyond the relacquering of the eye-ends, the finders, reading microscopes, and other parts attached to the tubes, there are several small improvements which have been left over, such as fitting of more convenient scales and illumination to the micrometer, the adjusting and fixing of the declination microscopes, the covering of apertures in the visual tube. Everything, however, which would involve the laying up of the instrument or interfering with the mount has been done: the outstanding improvements can be carried out as opportunity offers."

Several small improvements have been made to the Transit Circle, mainly on Mr. Chatwood's initiative. The wooden bar from which the striding level was suspended, which obscured the zenith, has been replaced by a movable rod, and the illumination of the field has been arranged from the object-glass, somewhat after the manner recently adopted at Greenwich.

The micrometers lent to Mr. Saunder, Mr. T. J. Moore, and Professor J. B. Dale, as mentioned in the last Report, are still in use. Mr. Moore is measuring such new plates as are taken to replace those of our series which were passed as satisfactory in the earlier years of the work, but do not come up to the improved standard of later years. By our method of printing the later work first, we are enabled to revise and improve the earlier work as we come to it, thus rendering the whole more homogeneous. In November last a micrometer of the improved pattern, with Zeiss' scale and objective, was sent to him in place of the early-pattern instrument which he had been using, and which was returned to the Observatory. A new scale and objective are being fitted to it, but the work will apparently take some months. It was by reason of the long time required for the construction or alteration of these instruments that we parted with our fourth instrument under the following circumstances: Mr. W. E. Cooke, Government Astronomer for West Australia, after many vexatious delays, recently obtained funds for measuring the Perth plates (Zones -32° to -40°). He had one micrometer, but was anxious to secure a second as soon as possible, and at his request the Agent-General for South Australia asked for our help in the matter. On inquiry it seemed impossible to avoid a delay of some months if a new machine was to be constructed, and the best way of helping our colleague in this work seemed to be to send one of our own instruments. They were as a matter of fact all in regular use for re-examination and revision of plates, but one of them could be spared without much inconvenience, and suitable terms were easily arranged. The instrument was accordingly sent to Perth on November 6.

The sunshine recorder, which had for some time failed to work, was thoroughly overhauled by Mr. Chatwood, but the alterations for which he arranged are not yet complete.

Arc lamps have been obtained for the photometric apparatus (measurement of coronal photographs) and the lantern. Previous photometric work had been done with a borrowed lamp, but this led to interruptions at inconvenient times.

IV. Observations and Reductions.

The reading of proofs, the consequent examination of discrepancies, the preparation of fresh copy to send to the printers, and as much re-measurement of the less satisfactory plates as we can manage, continue to absorb most of our energies, and will do so for another two years. Some general discussions of the results have been started, in preparation for Volume VIII.

V. Printing and Publication of Results.

Volume III (Zone $+29°$) and IV (Zone $+28°$) are printed and bound, and part of Volume VI (Zone $+26°$) is printed; so that the rate of one volume in six months has nearly been maintained so far.

It has been decided to print Volume VI before Volume V, because the plates with centres in declination $+26°$ do actually cover the portion of our zone still remaining, though only once. The zones $+27°$ and $+25°$ overlap the N. and S. halves of this portion and give a second measure, valuable for check; but once Volume VI is printed it will be possible to obtain a good star position in any part of the region assigned to us in 1889.

Of each volume 200 copies are bound in cloth, and the rest in paper. Of the paper copies, 100 of each volume are at present, by the courtesy of Bodley's Librarian, deposited in the Savilian Library, as a safeguard against loss of the whole impression by fire.

Volumes I and II were distributed in May last, and the distribution of Volumes III and IV is proceeding. This work presses very heavily on our small staff. The expense of transmission abroad has been much reduced by the general courtesy of the foreign embassies. On representation being made to them that the volumes contained the scientific results of an international undertaking, facilities were cordially granted for minimizing the trouble and expense of postage.

The total weight of the copies of each volume to be distributed is nearly a ton.

The following papers have been published by members of the staff during the year:—

"Note on the Range in Brightness at Maximum of long-period Variables." By H. H. Turner, *Mon. Not.* LXVII, p. 489 (May, 1907).

"On the Inclinations of Binary Star Orbits to the Galaxy." By T. Lewis and H. H. Turner, *Mon. Not.* LXVII, p. 498 (June, 1907).

"On the Measurement of a Meteor Trail on a Photographic Plate." By H. H. Turner, *Mon. Not.* LXVII, p. 562 (Nov., 1907).

"Note on the Position of the Sun's Axis of Rotation, as deduced from Greenwich Sun-Spot Measures, 1886–1901": Papers of the I.U.S.R. Computing Bureau, No. 1. By H. H. Turner, *Mon. Not.* LXVIII, p. 98 (Dec., 1907).

"Lord Kelvin." By H. C. Plummer, *Pub. Ast. Soc. Pacific*, Vol. XX, No. 118, 1908, Feb. 10.

"Variable Stars." Abstract of a Lecture delivered at the Meeting of the Brit. Astron. Assoc. held on February 26, 1908. By H. H. Turner, *Jour. Brit. Astron. Assoc.*, Vol. XVIII, p. 201.

"Note on A.G.C. Camb. 2,992." By H. H. Turner, *Ast. Nach.*, Band 177, Nr. 4,240, 249.

"On the relative numbers of Star Images photographed in different parts of the plates for the Oxford portion of the Astrographic Catalogue." Second paper. By H. H. Turner, *Mon. Not.* LXVIII, p. 397 (Mar., 1908).

VI. Lectures, &c.

The course of Lectures by the Professor on the Astronomy required for the Mathematical Final Schools was delivered in the Michaelmas and Hilary Terms as usual, and practical instruction has been given by the Professor in the Hilary Term. The absence of Mr. Plummer in America made it difficult to do more in this direction.

VII. Personal Establishment.

An announcement was made during last Long Vacation of a vacant Fellowship at the Lick Observatory, California, for one year. Mr. H. C. Plummer asked for permission to apply for it, and, after consulting the Vice-Chancellor, this was given, and approved by the Board at their meeting last November. Mr. Plummer arrived at the Lick Observatory on September 12. He will thus have an opportunity of working with some of the best modern equipment in a line of research not hitherto represented in Oxford, and on his return his experience will be a valuable guide in determining whether our plans for the future should include any work of this kind. On the other hand, it is hoped that his help has been welcome at the Lick Observatory at a time when several members of the staff, including the Director, have been away on the expedition to observe the eclipse of January 3, 1908. On the eve of his departure for the eclipse (November 17) Professor W. W. Campbell was kind enough to write expressing his appreciation of the rapidity with which Mr. Plummer had learnt work so new to him.

The absence of Mr. Plummer has naturally thrown more work on other members of the staff, especially on Mr. Bellamy; and his devotion to the interests of the Observatory has been closer than ever, if that is possible. Mullis has also had much extra work in the endeavour to complete the instrumental repairs during the limited time at Mr. Chatwood's disposal.

The appointment of Mr. A. B. Chatwood as a temporary member of the staff, under circumstances above mentioned, was approved by the Board at its meeting in November last. The appointment lasted from October 15 to February 15. The experiment proved entirely successful, and our only regret is that the time was too short to do all that might have been done with his help. He is now at Hyderabad planning the Nizam's new observatory, and our good wishes go with him in his new appointment.

Mr. T. J. Moore continues to measure plates for revision, as above mentioned. Miss E. F. Bellamy has undertaken all the clerical work connected with the distribution of the volumes, besides much miscellaneous work in photography, library, &c. Her services during the past year are worthy of special mention. Mr. A. C. T. Roberts resigned his position as Computer last June. Mr. O. J. B. Cole and Mr. S. C. Cook are still at the Observatory, though the latter is on the point of departure. They have worked well during the year.

VIII. General Remarks.

The Director attended the meeting at Meudon (near Paris) of the International Union for Solar Research, May 20–24, 1907. At the request of the Union he has undertaken to establish a Computing Bureau, and a start has been made on a small scale with funds supplied from a private source.

He also attended, as a delegate of the Royal Society, the meeting of the International Association of Academies at Vienna (May 28–June 1), and was nominated on the Committee on Lunar Nomenclature, of which he was subsequently appointed Secretary.

H. H. TURNER.

April 30, 1908.